



## Discussion

## Reply to comment on “Carbon-isotope record of the Early Jurassic (Toarcian) oceanic anoxic event from fossil wood and marine carbonate (Lusitanian Basin, Portugal)”

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McArthur's comment focuses on the origin of a negative carbon-isotope excursion reported from terrestrial and marine organic matter and marine carbonate in Early Jurassic (Toarcian) strata from a number of localities in northern and western Europe. He argues that the absence of a clear negative excursion in belemnite calcite falsifies the hypothesis that the observed negative excursion in other materials originates from a methane source. We note that McArthur telescopes the argument that we present: in our paper we firstly interpret the new data as supporting the hypothesis that isotopically light carbon dominated the global ocean–atmosphere–biosphere carbon reservoirs during the Early Toarcian Oceanic Anoxic Event (OAE), and secondly conclude that this phenomenon could be explained by a massive input of carbon from a methane source.

As we discuss in the paper, the belemnite  $\delta^{13}\text{C}$  values could only be regarded as falsifying this hypothesis were it to be shown unambiguously that belemnite calcite more

accurately recorded the isotopic characteristics of global carbon reservoir than all the other lithological constituents. We have already noted the difficulty of accurately locating samples on extensive foreshore exposures where the dip is at a low angle and, because belemnites are typically absent from strata displaying the peak of the negative excursion, assignment of specimens to these levels needs to be documented with particular care. Moreover, because belemnites must have been active swimmers, inhabiting different geographic areas and different levels in the water column, their carbon-isotope ratios cannot always be relied upon as monitors of a global ocean reservoir, particularly at times of extreme ocean stratification. The coccolith-bearing bulk carbonate from Peniche, on the other hand, is stratigraphically located with centimetric accuracy; it cannot have been derived from actively swimming organisms, and most likely records the isotopic characteristics of the surface waters of the Lusitanian Basin.

McArthur is also mistaken in suggesting that the local absence of the negative excursion in datasets from some other European sections somehow proves that the excursion was not a global phenomenon. A well-known property of the stratigraphic record is that it is commonly extremely condensed or incomplete. Furthermore, the

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